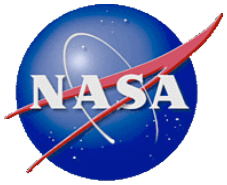
National Aeronautics and Space Administration



An Impact Sensor System for the Characterization of the Micrometeoroid and Lunar Secondary Ejecta Environment

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Outline

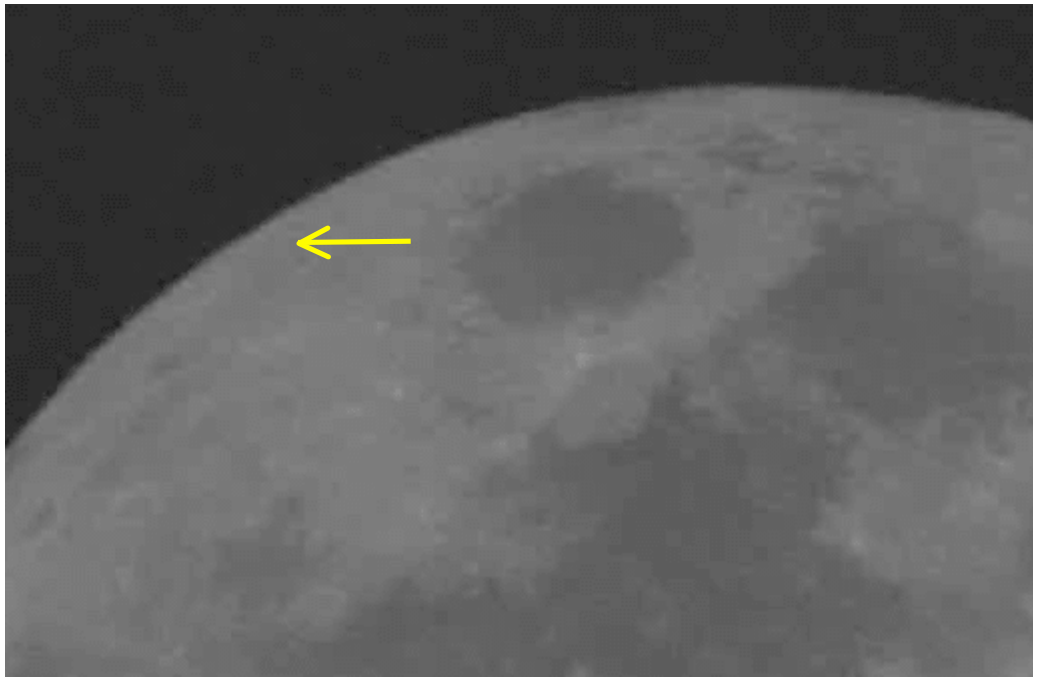
- Project objectives
- Lunar particle environment
- Benefits
- System overview
- Current status
- Plan forward

Objectives

- **Short-term: Conduct Pre-Phase A and Phase A activities of two integrated micrometeoroid and lunar secondary ejecta (MMSE) impact detectors**
  - Impact Sensors for Micrometeoroid and Lunar Secondary Ejecta (IMMUSE)
  - Funded by the NASA LASER Program through 2011
- **Long-term: Conduct MMSE *in situ* measurements on the Moon to better define the particle environment for future lunar exploration activities**

Lunar Surface Environment (1/3)

- **The Moon continues to get bombarded by meteoroids from space**

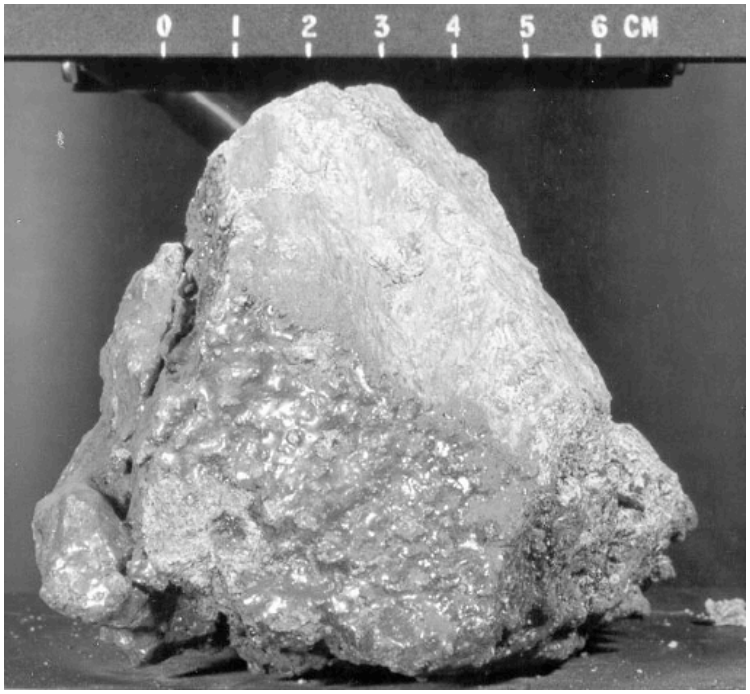


(Leonid meteoroid impact, 2006)

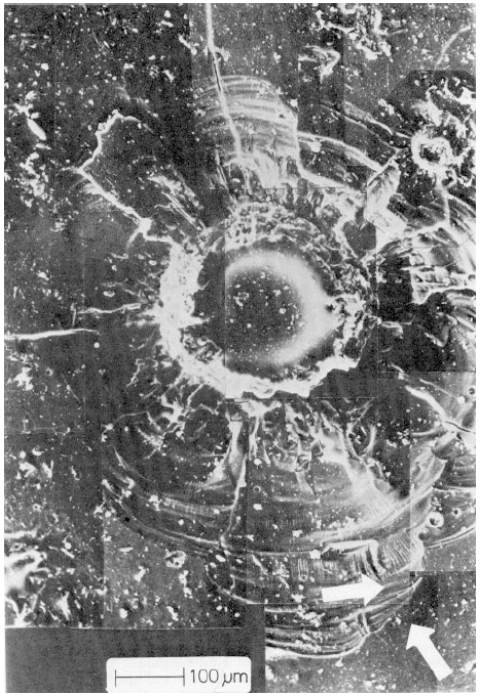
- **Total EVA time from the 6 Apollo missions: ~80 man-hours**

Lunar Surface Environment (2/3)

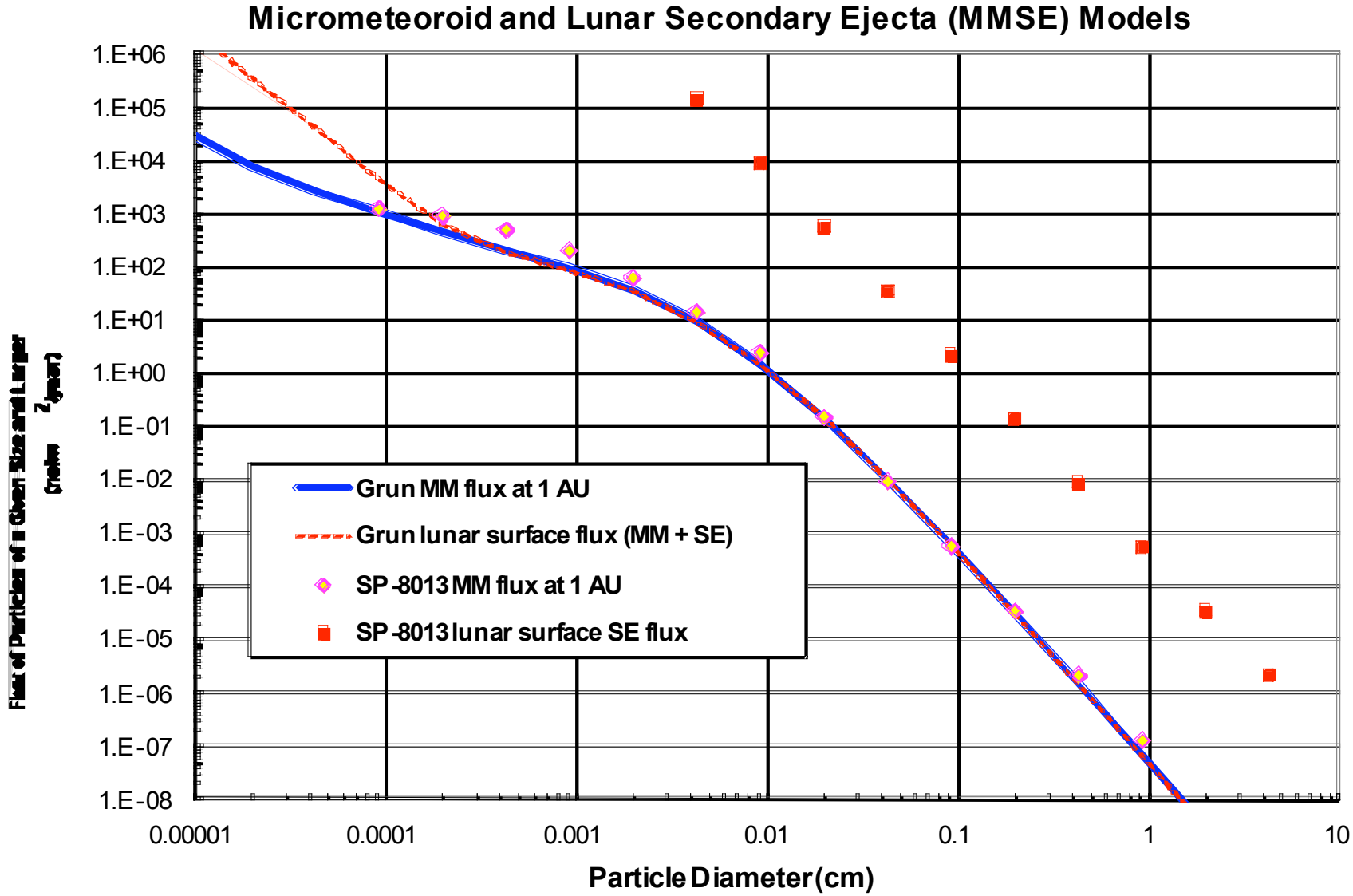
- **Micrometeoroid (MM) flux on the surface of the Moon**
  - "Order-of-magnitude" estimates
    - **The Moon: 2×10^6 impacts/year by MM 1 cm and larger (up to ~70 km/sec)**
    - **A field area the size of JSC: ~2700 impacts/year by MM 1 mm and larger**
      - **@70 km/sec, a 1 mm micrometeoroid can penetrate 1.1 cm-thick Al wall**



Lunar rock 12054



Lunar Surface Environment (3/3)

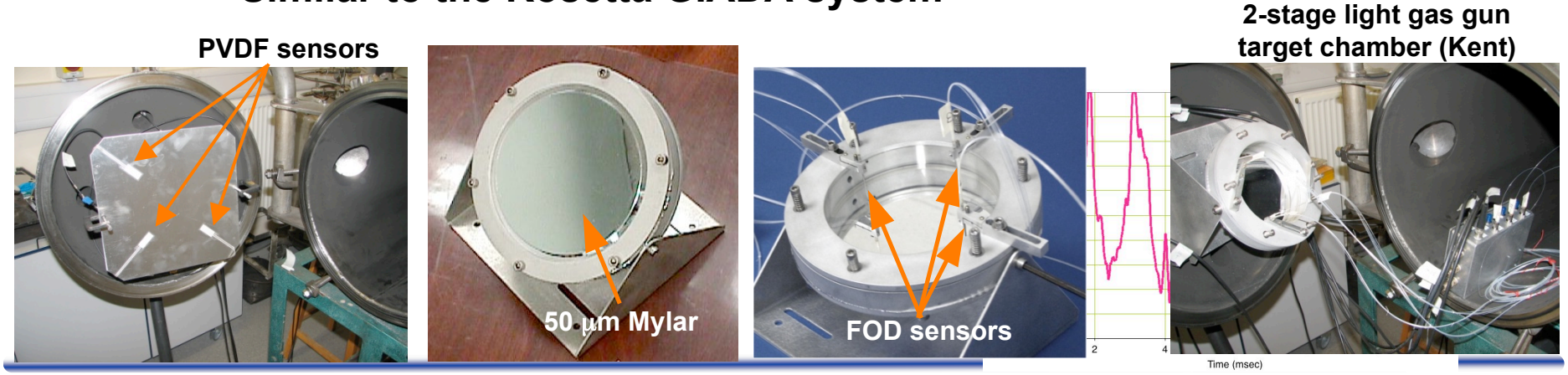


Benefits of the Project

- **Fundamental Lunar Science**
  - Acquire data to improve the understanding of lunar cratering processes and the growth, mixing, and transport of the lunar regolith.
- **Lunar Exploration Applied Science**
  - Provide data for (a) conducting reliable impact risk assessments for human lunar exploration activities, (b) designing cost-effective shielding for habitats, and (c) developing mitigation measures to address dust contamination issues.
- **Planetary Science**
  - Place constraints on the collision history of asteroids, and the release of materials from comets into interplanetary space. Provide a reference to study other regolith-covered Solar System bodies from remote-sensing data.

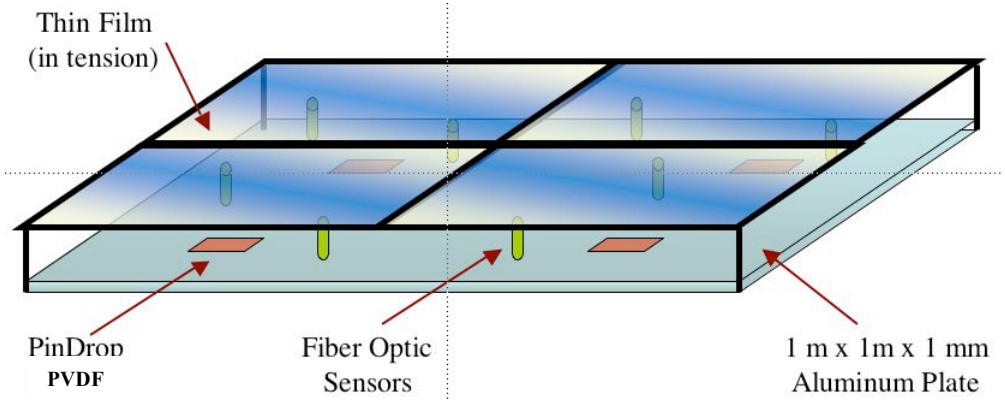
IMMUSE System Overview (1/2)

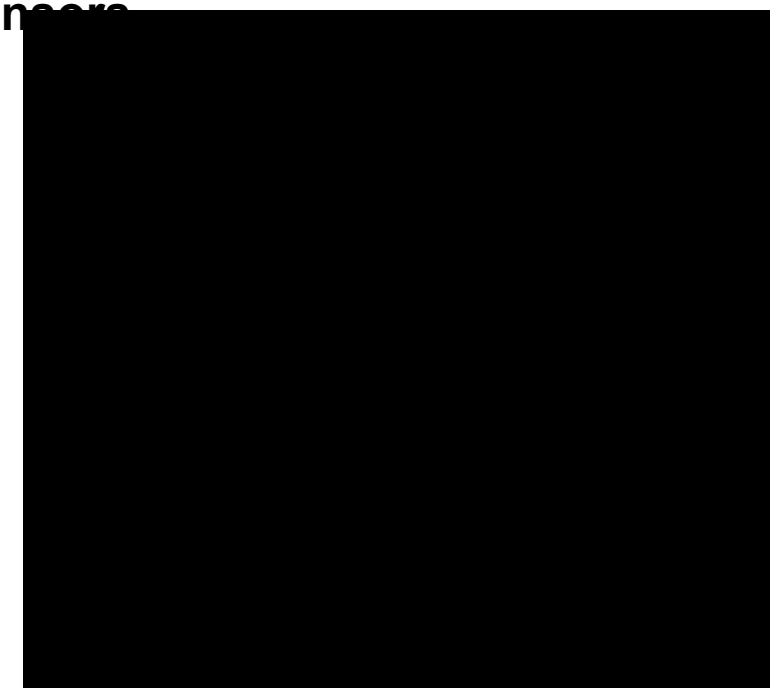
- **The IMMUSE system makes use of three proven particle detection technologies**
  - Impact acoustic detection
    - **Using polyvinylidene fluoride (PVDF) as impact acoustic sensors**
    - **Development funded by the NASA PIDD Program 2003-2005**
  - Fiber optic displacement (FOD) detection
    - **Using FOD sensors to detect impacts on a thin film under tension**
    - **Funded by JSC Mission Enabling Science Program through 2012**
  - Dual-layer laser curtain detection
    - **Similar to the Rosetta GIADA system**



IMMUSE System Overview (2/2)

- **IMMUSE consists of two sub-systems**
  - Micrometeoroid Impact Detection System (MIDS)
    - **FOD + PVDF sensors**
    - **The building block for a large area (>tens of m^2) detector**
  - Secondary Ejecta Detection System (SEDS)
    - **Dual-layer laser curtain + PVDF sensors**
    - **10 cm × 10 cm detection area**





Development Status

- **PVDF impact acoustic sensor**
  - Identified sensor materials for extreme temperatures and tested various backing plates
  - Conducted hypervelocity impact tests for signal characterization
- **Fiber optic displacement sensor**
  - Designed, fabricated, and tested various configurations of the film support
  - Built prototype units for low velocity and hypervelocity impact tests
- **Dual-layer laser curtain system**
  - Constructed a low speed particle launching device
  - Finalized the preliminary design of a single curtain system
  - Procured the parts needed for a prototype unit

→ **Will continue the development of IMMUSE through 2011**

Summary

- **Micrometeoroid and lunar secondary ejecta data are needed to better support engineering, science, and impact risk assessment applications**

- **Roadmap for the IMMUSE project**
  - Reach a Technical Readiness Level (TRL) of 3 by the end of the current LASER support in preparation for a more advanced development beyond 2011
  - Seek opportunities to collaborate with other organizations and agencies (U.S. and international) for cost-effective instrument development/advancement and potential flight opportunities to the Moon